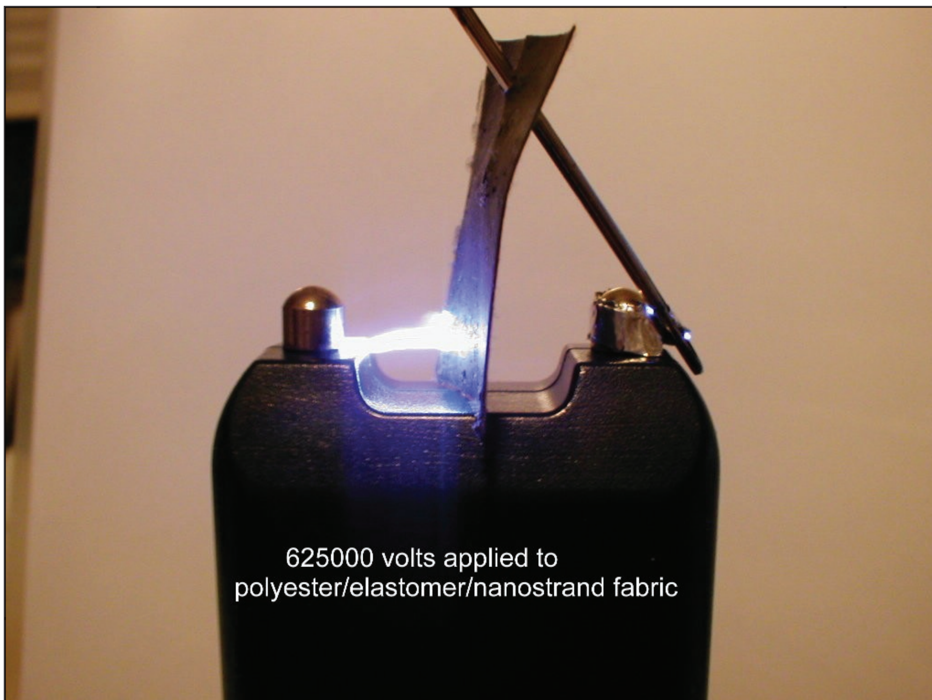
Success Story

NICKEL NANOSTRANDS™ EXPAND NANOTECHNOLOGY ENGINEERING CAPABILITIES



Manufacturers can engineer nickel nanostrands to meet the diameter and length specifications in many fields of submicron and nanostructure design. They have produced diameters ranging from 50 nanometers (nm) up to 2 microns with aspect ratios generally in the 50:1 to 500:1 range.

Researchers hope to produce nanostrands in the range of 10-30 nm in diameter. Further development could lead to advancements in nanotechnology directly benefiting the Air Force, aerospace community, and industry at large.

Air Force Research Laboratory
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Accomplishment

Researchers at the Materials and Manufacturing Directorate, working with Metal Matrix Composites of Heber, Utah, developed a new form of nanostructured nickel that dramatically expands nanotechnology design engineering capabilities. The new materials are called nickel nanostrands and were developed under Phase I of an Air Force Small Business Innovation Research program.

Nickel nanostrands are strands of submicron-diameter nickel particles linked in chains—microns to millimeters in length. They are very similar to carbon nanofibers but provide the additional properties of nickel, significantly expanding the variety of options available for developing tomorrow's nanostructure technologies.

Background

Nickel nanostrands are analogous to carbon nanofibers (or multiwall carbon nanotubes) but bring the additional electromagnetic, chemical, catalytical, and metallurgical properties associated with nickel to the nanostructure design engineer's toolbox. These new materials demonstrated their utility in creating conductive resins, paints, adhesives, and thermoplastics for a wide range of conductive polymer and conductive composite applications. Researchers at Metal Matrix Composites, for example, have created paints with a sheet resistance of less than 1 ohm per square, and adhesives and thermoplastics with conductivities of 40 Siemens per centimeter (S/cm) and 150 S/cm, respectively.

Nickel nanostrands can also further enhance the conductivity of fiber- or particle-reinforced composites, thus providing a three-dimensional conductive lattice in the otherwise insulating polymer resin matrix. A loading of only 2% of volume in an otherwise standard prepreg, for instance, doubles the conductivity of a carbon fiber composite. This is important for the Air Force and industry because infiltrated carbon composites have proven highly useful in lightning strike protection for aircraft and other composite structures.

Additionally, when manufacturers add nickel nanostrands to elastomers, the resulting composite material exhibits remarkable changes in conductivity with respect to tensile or compressive strain. Since nickel nanostrands are a magnetic material, researchers can magnetically align them while the carrier is still in the liquid phase, yielding a whole range of unique applications such as magnetically oriented inks or magnetically aligned conductive fibers. The unique microstructure and chemistry of nickel nanostrands could also lead to important advancements in filtering, catalysis, energy storage, and nanometallurgy.

Materials and Manufacturing
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (03-ML-51)